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RESEARCH ARTICLE

EXAMINING THE RELATION BETWEEN PERSONALITY, EXPECTANCY-VALUE AND ATTITUDE TOWARDS SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM), IN THE PROJECT-BASED LEARNING (PJBL) ENVIRONMENT

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ABSTRACT

Taiwan's education strategy is developing within process to fit the students' personal needs, interests and self- development. It is important to understand the Attitude and value factors that influence individual educational choices. In this article, the study conduct a literature review of the current knowledge surrounding individual attitudes in STEM, personality and using expectancy–value theory as a guiding framework. The overarching goal of this paper is to provide both a well-defined theoretical framework and complementary empirical evidence for linking specific external and internal factors to individual value differences in personality and STEM attitude. A sampling of 147 first-years of college students with health-care educational background was randomly selected from a technological university in Taiwan. Multiple research methods were adopted, including: the questionnaire consists of three constructs: STEM attitudes (thirty-eight items), students' expectancy–value (eleven items), and students' personality (thirty-two items). The results of the questionnaire analysis are as following that students had a positive attitude towards STEM, especially technology and engineering are the most popular subject with using expectancy-value. However, that there were significant differences of STEM attitudes depending students' different personality traits, especially in the dimensions of Openness, Extraversion, Conscientiousness. Most of the students had weak significantly attitudes only towards the science, engineering and technology disciplines in the STEM.

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INTRODUCTION

In 2012, there were approximately 7.4 million STEM positions in the U.S., and this number is expected to grow to 8.65 million by 2018 (My College Options & STEM connector, 2012). As the world becomes increasingly technological, the value of these national assets will be determined in no small measure by the effectiveness of Science, Technology, Engineering, and Mathematics (STEM) education (Holdren, Lander, & Varmus, 2010). STEM courses are often viewed as difficult and sometimes unrelated to reality. Some studies argued that Students choose not to complete STEM degrees for numerous reasons including uninspiring introductory courses or the lack of preparation and support to complete mathematics courses (Holdren & Lander, 2012). However, other studies have demonstrated that as the percentage of female faculty in STEM departments increases, the percentage of four-year degrees awarded to females in these departments will also increase (Qian, Zafar, & Xie, 2009). In the point of view of Osborne *et al*. (2003), student attitude towards enrolling in a course is a strong determinate of a student's choice in pursuing future careers. Attitude is made up of emotion, cognition and intention (Myers 1993). It can also be viewed as individual beliefs about the attributes of a particular object (Fishbein and Ajzen 1975), some behavioral studies have used attitude to explain behavioral intentions (Karahanna *et al*., 2008) and may be influenced by various other attributes (Ajzen 2001; Crano and Prislin 2006). Project-based learning mainly process include the construction knowledge by definition of newunderstandings or skills, decision-making, problem-finding, problem-solving, discovery, ormodel-building

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procedures (Bereiter & Scardamalia, 1999). Through practical activities, interactive discussions, independent operation or team cooperation, students achieve their goal and establishtheir own know-how. Bell (2010) states that project based learning (PjBL) process focuses onself-learning in an empirical project and students become better researchers, problem solvers, and higher-order thinkers. This study was through integrating science, technology, engineering and mathematics into a project-based learning procedure, that students were more willing to learn science knowledge via practical methods. Therefore, PjBL plays a significant role in exposing students to a meaningful learning process while they are engaged in completing their project. Personality is related to various aspects of students' attitudes and behavior in educational settings (Tokar, Fischer, & Subich, 1998), because that involved the Personal with its interests, needs and possibilities to go beyond abilities to self-realization of creative potential, directivity to self-development and self-education during whole life. Some studies indicated people select environments in which they can express their interests and that these environments are influenced by the people within them. Most studies addressing the relationship between personality and vocational interests use the Big-Five factor structure of Goldberg (1992) to categorize personality into five large domains: extraversion, agreeableness, conscientiousness, emotional stability (or inverse neuroticism), and openness to experience(McCrae, 1992) or autonomy (Hendriks, Hofstee, & de Raad, 1999a).Consistent evidence has been found for four relationships: the personality factor extraversion is related to social and enterprising interests and the personality factor openness to experience to artistic and investigative interests (e.g. Larson, Rottinghaus, & Borgen, 2002).

On the other hand, Eccles' expectancy–value theory provides one of the most comprehensive theoretical frameworks for studying the psychological and contextual factors underlying both students' differences in math and science academic motivation, performance, and career choice (Wigfield & Eccles, 2002). The reason for that is because of students had the some differences experiences from the outcome feedback and emotional memories of various activities. All the time, those feedback outcome and emotional memories accumulate to develop the expectancy value link with their educational choices (Eccles, 2009). Recently, Taiwan technological university faced the low birth rate and growing numbers of universities; Taiwan's education strategy is developing within process to fit the students' personal needs, interests and self-development As a result, a better understanding of student personality and their relationship between STEM attitude and expectancy–value would lead to instructional and curricular changes. The overarching goal of this paper is to provide knowledge gained through this review may eventually guide future research and interventions designed to enhance individual motivation and capacity to pursue STEM attitude, particularly for differences between individual personality and their expectancy-value.

Research method

For the purpose of this study is able to explore the relationship between the STEM attitudes and students' expectancy–value for the first step and the second step will consider to what is the better predictor of students' personality toward STEM attitudes within expectancy-value. The following two major constructs are employed and operational zed: STEM attitudes regard students' expectancy–value, and STEM attitudes regards students' personality who participated in body and facial practical skill program from the Health-care department of a Taiwan Technology University. In order to integrate STEM, the design of the Health-Care project include multi-disciplinary components of physiology, biology, psychology, social science, chemistry, facial skill program, body massage program, consumer psychology, service marketing management, salon business management, mathematic, customer behavior, application of Chinese medicine, application and practice of Aroma therapy, etc., which were related to the curricula that students had learned from a technological university. The project-based learning procedure students used through integration science, technology, engineering and mathematics to see how their personality to assist their effective learning attitude and expectancy-value, also students were encouraged to resolve problems, finally to enhance their ability for learning situation.

A sampling of 147 first-years of college students with health-care educational background was randomly selected from a technological university in Taiwan. Multiple research methods were adopted, including: literature review, questionnaire with the measuring scales for these constructs are adopted from previous studies; the questionnaire consists of three constructs: STEM attitudes (thirty-eight items), students' expectancy–value (eleven items), and students' personality (thirty-two items). Participants were to respond on a 5-point Likert scale (1 = totally inapplicable to 5 = totally applicable).Construct validity using factor analyses and regression models were established.

Analysis and Results

The 81-items scale consists of different students, describing their attitudes and the change of student attitudes towards the four subjects of STEM attitudes with using personality and expectancy-value. The correlations for the STEM attitude and expectancy-value are also presented in Table 1. The results of the questionnaire analysis are as following that students had a positive attitude towards STEM, especially technology and engineering are the most popular subject with using expectancy-value. As shown in Table 1 except for attitude toward engineering and with using value of interest which correlate with a value of 0.517; for attitude toward engineering with using value of utility which correlate with a value of 0.521; for attitude toward engineering with using cost of success of failure which correlate with a value of 0.572 . Also students are interested in attitude toward technology career and with using value of attainment which correlate with a value of 0.550, for attitude toward technology career with using the value of interest which correlate with a value of 0.550 and for attitude toward technology career and with using the value of utility which correlate with a value of 0.505, for attitude toward technology career with using cost of success of failure which correlate with a value of 0.601which demonstrates that the change of student STEM attitudes with using expectancy-value are somehow related.

Table 1. Correlations between STEM attitude and Expectancy-value

STEM / Expectancy value	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12
EC	.153	.265**	.294**	.384**	.271**	.129	.204*	.241**	.317**	.217**	.147	.147
ES	.167*	.268**	.202*	.456**	.278**	.145	.240**	.302**	.422**	.316**	.240**	.231**
EE	.173*	.286**	.257**	.458**	.295**	.149	.242**	.298**	.407**	.296**	.217**	.212*
VS	.230**	.209*	.233**	.488**	.266**	.260**	.161	.352**	.550**	.337**	.202*	.229**
VI	.221**	.277**	.270**	.517**	.181*	.202*	.223**	.383**	.550**	.315**	.173*	.226**
VU	.286**	.289**	.339**	.521**	.220**	.164*	.284**	.306**	.505**	.348**	.159	.243**
VV	.276**	.292**	.316**	.572**	.249**	.234**	.251**	.390**	.601**	.374**	.199*	.261**

Note. SS1：attitude toward science, SS2：attitude toward learning science, SS3：attitude toward science career, SS4：attitude toward engineering, SS5：attitude toward learning engineering, SS6：attitude toward engineering career, SS7：attitude toward technology, SS8：attitude toward learning technology, SS9：attitude toward technology career, SS10：attitude toward mathematics, SS11：attitude toward learning mathematics, SS12：attitude toward mathematics career, EC：expect competence belief, ES：expect for success, EE：expect for experiences,VS：value of attainment, VI：value of interest, VU：value of utility, VV：Cost of success of failure. ** $p \leq 0.01$, * $p \leq 0.05$

Table 2. Correlations between STEM attitude and personality

Personality / STEM	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12
EX(extraversion)	.197*	.160	.264**	.199*	.278**	.256**	.174*	.145	**.323****	.178*	.211*	.246**
AG(agreeableness)	.253**	.093	.237**	.173*	.229**	.021	.157	.062	.207*	.157	.109	.205*
CO(conscientiousness)	**.301****	.204*	.260**	**.325****	.245**	.047	.259**	.234**	**.331****	.216**	.080	.150
EM(emotional)	-.100	.006	.183*	.097	-.006	-.001	.005	.000	.191*	-.017	.085	.144
OP(openness)	.268**	.195*	.258**	**.392****	.252**	.237**	.247**	.190*	**.306****	.231**	.255**	.204*

Note. SS1：attitude toward science, SS2：attitude toward learning science, SS3：attitude toward science career, SS4：attitude toward engineering, SS5：attitude toward learning engineering, SS6：attitude toward engineering career, SS7：attitude toward technology, SS8：attitude toward learning technology, SS9：attitude toward technology career, SS10：attitude toward mathematics, SS11：attitude toward learning mathematics, SS12：attitude toward mathematics career,** $p \leq 0.01$, * $p \leq 0.05$

Table 3. The description of student designing Health-Care through applying STEM knowledge

Problem	Science/mathematics	Technology	Engineering
	1. The types of difference skin's function, structure, problems, and characteristics was figured out. 2.The concepts of using the electrotherapy for skin-care 3. The concepts of using physiological effects of facial massage. 4. Applying high-frequency current with facial electrode. 5. The knowledge and concepts of materials for different skin-care types requirements.	1. Use the wood's lamp to ensure the skin problem and facial vaporizer to make the skin cleaner. 2. The high-frequency machine was used as the major proceeding for treating skin diseases. 3. The suction machine was used in the skin condition of disincrustation and could increase the skin repair function.	1. Design the skin-care service procedure via each difference skin types requirements for operating the machines, tools and skin care material. 2. The major concepts of design include skin structure, problems characteristics, equipment and suitable material function for repairing skin problems. 3. To Customize treatment through the skin characteristics. 4. Regarding the high-frequency machine and functional materiel are applied to repair and recover the skin condition.

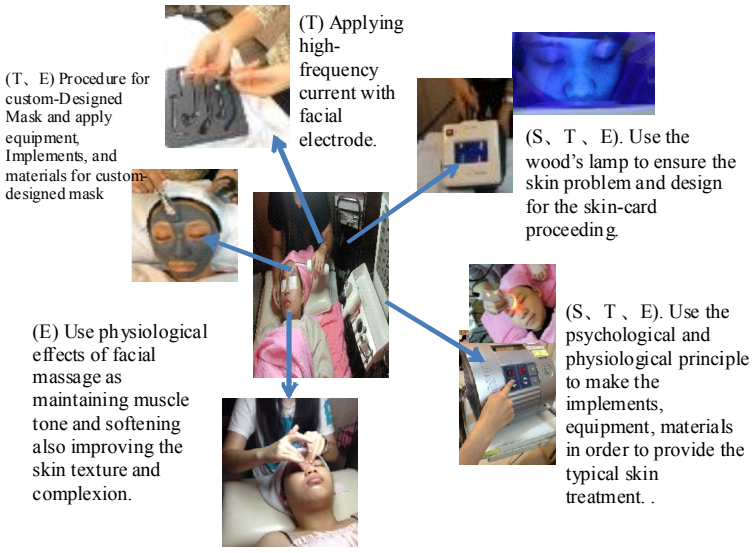

Figure 1. The dry-skin problem (health-spa-care) that designed by students

As regards the relationship between the STEM attitudes and students' expectancy–value, most values correlated significantly. In Table 2 indicated that there were significant differences of STEM attitudes depending students' different personality traits, especially in the dimensions of Openness, Extraversion, Conscientiousness. Most of the students had weak significantly attitudes only towards the science, engineering and technology disciplines in the STEM. Such as for attitude toward science and with Conscientiousness personality with a value of 0.301; for attitude toward engineering and with Conscientiousness and Openness which correlate with a value of 0.325 and 0.392. Also students are interested in attitude toward technology career and with personality Extraversion, Conscientiousness and Openness which correlate with a value of 0.323, 0.331 and 0.306.

DISCUSSIONS AND CONCLUSIONS

In this present study, through the results the theoretical model of expectancy-value and personality application in this study, however, appears to have little explanatory power in predicting students' cognitive learning in STEM education, the predictability the personality and expectancy-value theory in students' STEM performances appears to be small, although significant. Students presented positive attitudes towards science engineering and technology. A slight change of student attitudes towards science was found during the PjBL activity. Please to see the student designing Health-Care through applying STEM knowledge in Table 3 and Figure 1, the majority of students indicated that science could be applied to solve real world problems and to increase effectiveness in daily lives. The possession of health-care expertise regards to apply technology to be beneficial for pursuing future careers and was the major reason to inspire student interest and intention in learning science. In terms of learning strategies, students were more likely to acquire scientific knowledge through practical work. The PjBL strategy was thus applied in the present study in order to promote students' intention in learning science related knowledge. Osborne and Collins (2000) and George (2006), argued that students were more willing to learn science knowledge via practical methods. They argued that students' personal autonomy and interest in learning science may be enhanced through PjBL strategy.

The expectancy-value theory can still be promissory for the domain of STEM education if researchers started to examine the construct and the theory from a different perspective. We also need to understand what the factors and elements are that are perceived of task values and expectancy beliefs, and what the factors are that could cost/diminish them. Once we understand these issues, the theory could be refined, and the measure of its constructs could be re-conceptualized and re-constructed in and for STEM education. When students value the content and feel confident about their ability in learning the content, they are likely to achieve in learning, and to apply the knowledge and skills learned to their lives (Usher, 2009). The personality factor conscientiousness had relatives' attitudes only towards the science, engineering and technology disciplines in the STEM. That is similar approval within Cellar *et al*. (2001) found conscientiousness and agreeableness as the two most influencing personality types in workplace environment, therefore the interests of STEM-related students of technological university in Taiwan may well represented by just indicating a direction of interest toward the realistic and investigative via practical methods and assessing self-evaluations with expectancy-value in STEM performances.

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